Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development
Vol. 23, Issue 4, 2023
PRINT ISSN 2284-7995, E-ISSN 2285-3952

SOME ENVIRONMENTAL PARAMETERS VERSUS VEGETATIVE AND FRESH PODS' YIELDS OF OKRA (*Abelmoschus esculentus* L. *Moench*)

Wasiu Agunbiade LAMIDI[1], Michael Segun AFOLABI[2], Mosobalaje Abdulsalam MURTADHA[2], Kabiru Alani SHITTU[2], Elizabeth Abiola OJELEYE[2]

[1]Osun State University, Faculty of Engineering, Department of Agricultural Engineering, Osogbo, Nigeria, Phone: +2348135860977; E-mail: wasiu.agunbiade@uniosun.edu.ng
[2]Osun State University, College of Agriculture, Department of Agronomy, Ejigbo, Osogbo, Phone: +2348060351474; E-mails: michael.afolabi@uniosun.edu.ng, mosobalaje.murtadha@uniosun.edu.ng, kabiru.shittu@uniosun.edu.ng, abiola.ojeleye@uniosun.edu.ng

Corresponding author: wasiu.agunbiade@uniosun.edu.ng

Abstract

The research work evaluated the yields of fresh pods and vegetativeness of okra (Abelmoschus esculentus L.) leaves when they were naturally subjected to different environmental parameters at two different years. The okra crops were planted two times, in the rainy season of 2019 and in 2020 between May and August. Temperature and humidity values were taken at 10.00 h and 14.00 h daily from School meteorological unit. Temperature-Humidity-Index (THI) values were computed. Yield parameters namely plants' heights, Leaf Area Index (LAI), number of leaves, stem girth, cumulative yields of leaves and okra fresh pods were measured. Results show that okra planted in 2019 gave the highest vegetative yield via LAI (398.50 m^2) and number of leaves (16.50) in 2019, the values in 2019 have increase of 9.57% and 8.91% respectively over their corresponding values in year 2020. Also, the THI directly affects the growth rates, yield components and average cumulative yields of fresh okra pods at the significant difference ($P \leq 0.05$).Years of planting and season of planting, temperature and humidity of the environment affect the yield and yield components of okra and the project is feasible in economic sense.

***Key words*:** *leaf area index, plants' heights, seasons of the year, THI-temperature and humidity index*

INTRODUCTION

Okra (*Abelmoschus esculentus* L.) is a crop that can be planted as leafy vegetable as well as fruit vegetable, because its leaves and fruits are eaten raw or cooked. It has high nutritious fresh leaves and fresh fruits which can help to normalize sucrose and assist to control the rate at which sucrose is stored in both animals' and human bodies [15]. Okra is planted in different parts of the world, Africa, America, Asia and Europe and they are affected by different factors like soil types, breeds, environmental factors among others [15, 7, 9]. Okra's leaves and fresh fruits are used among south western people of Nigeria to make soup- a delicacy of nutritive values. Okra soup is prepared after size reduction have been done to the leaves or the green fresh pods that are usually harvested when they are just about to be matured. The reason why harvesting is very timely is because when they are fully matured, they become more fibrous and non-delicate and non-delicious either raw or when cooked. Otherwise, the pods are left to dry for the seeds to be planted in the next season. Okra is a good source of vitamins, minerals, fibres and antioxidants. It contains sticky, slippery, 'slimy', highly viscous juice that people make use of to thicken sauce [3, 1, 4]. The fresh fruit pods while eaten raw or cooked drops, and is slippery or 'slimy' mouth feel.

In the face of current global climate change, there is a need for improving on better production techniques toward increment in the yield of the okra; to further improve its overall yields in vegetativeness and fresh pods, especially now that the world is facing global warming, some other improvements in growing of crops are needed. These may be in the form of climatic modifications/integration at the crop surfaces. Or it may be strategical

planting of different kinds of crops according to seasons because seasons have been found to affect some yields of certain crops [16].

Although okra have been researched into by some previous works [15, 3, 6], the study of temperature and humidity on the plant still have to be researched into [6, 17, 8]. Because of the importance of okra to man and its multi-purpose uses, it has therefore become necessary to study okra production under different planting conditions with the intension to boost food supply.

The goal of this research was to evaluate the vegetativeness of leafy okra and the fresh pods' yield when they are exposed naturally to different temperatures and humidities at two different years.

MATERIALS AND METHODS

The field experiment was conducted at the Teaching and Research Farms of the College of Agricultural Production Management and Renewable Natural Resources, Osun State University, (7.8717; 4·3067) Ejigbo campus in 2019 and 2020. The vegetation and weather, just like in south west Nigeria where Osun State is situated, is rain forest type with two peaks of rain which is between 1,158 mm-1,250 mm per annum. The temperature is high all the year round with range between 28°C-33°C, range of relative humidity is 65-85%.The okra seeds were planted two times, in each of the rainy season between May and August -a period of about 120 days each in 2019 and in 2020 years. The variety of okra used was *finger nail okra* as it is popularly known in South Western Nigerian States. The conventional rate of 10 tons/ha of poultry manure was supplied to the plots4 weeks before the seeds were planted. The number of the weeks allowed all the soil to have mixed up thoroughly with the poultry manure to be able to be absorbed as nutrients for the crops. Temperature and humidity values were taken at 10.00h and 14.00h daily from School meteorological unit. Temperature-Humidity-Index (THI) values were evaluated using the following expression:

$$THI = t_{db}-[0.31(1-\frac{RH}{100})(t_{db}-14.4)] \text{ in } {}^{o}C \text{ [10]}$$

where:

THI = Temperature-Humidity Index

t_{db}= dry bulb temperature, ^{o}C

RH = relative humidity, %

The computed THI values were the results from combination of temperature and humidity as a degree of measure of comfort/discomfort experience by animals and by extension, by crops when computed from temperature and humidity values using THI equation [10]. Also, measured were plant height, number of leaves, number of branches, stem girth. Other parameters measured were plant heights using metre rule, number of leaves, and number of branches by direct counting of their number. Stem girth was also measured using vernier callipers. Besides, measured also were vein lengths using metre rule and leaf area index using portable leaf area metre, LI-COR LI-3000C, made in USA. The okra fresh fruits were harvested at 4 full days intervals (96 hrs) in compliance with the tradition in the area of the experiment. The leafy and fruit yields of okra were measured using standardized weighing scale(digital balance (Camry 50 kg weighing scale, model CA277HL, made in Nigeria).

The leaves' weights were measured only when they were about just to drop off from the plant. This period was closely monitored per leaf per plant to remove them for weighing before they turned into yellowish colour on the plant.

Mean cumulative weights of okra fruits and leaves were found at the end of the experiment for each of the years. There was a plot of land cultivated near the research plot which was planted normally with okra to serve as a control experiment.

It also has rate of 10 tons/ha of poultry manure supplied to it 4 weeks before the seeds were planted.

The farm plots used for both years were not on the same plot of land, adjacent lands were used to reduce interference. All the characters were subjected to descriptive statistics and one-way ANOVA.

RESULTS AND DISCUSSIONS

There were increments in number of leaves of okra during the first three weeks of growth especially in 2020. The increase in the number of leaves of okra during these earliest weeks could be as a result of foliage development, Figures 1 and 2, it could also be from some other factors, like the THI, a product from combined evaluation of temperature and humidity values. Because increase in vegetativeness of leafy okra will start from the development of foliage, and since these foliage's development happened as at when due (first two weeks after planting), it could be surmised that their ease of formation could be as a result of many factors. Some of these factors could be from the soil; changes in environmental parameters; breed of okra in use and the availability of nutrients in the soil just like it affects other green crops [5, 11]. More leaves were formed in the third week through to eighth week and especially in 2019 during which the number of leaves were continuously on the increase per plant, Figure 1.

For both years, there were statistical differences ($P \leq 0.05$)in the mean values, implying significant differences among some yield components of okra namely plants' heights, leaf area index and stem girth. However, it was not statistically/significantly different for the number of leaves as revealed in Table 1. This can be surmised to mean that the performances of okra were different for both years. This could be as a result of differences in the environmental parameters with temperatures and humidity values that were different in both periods, even though both seasons were rainy season.

There were variations in the temperature and humidity values collected from the experimental field spot in both years. Even though there were variations, but there were no statistical differences ($P \leq 0.05$) among the THI values in both years. But variations were enough to have the computed temperature-humidity index, THI values as shown in Table 2 to reveal non-uniformity at different stages of the growth in the weeks. The THI values were between the range 29.70 and 34.40^{o}C in 2019, this range was higher than what was obtained in 2020, notwithstanding all these are within the comfort zone for both animals and crops in the tropics and therefore suitable for the okra [11].

Also, each of the corresponding weekly THI mean values were more in 2020 than in 2019 except in week 2. This implies that 2020 was warmer than 2019, this may explain why all the growth and yield parameters in 2020 were less than their corresponding values in 2019. Implication could be that okra will not grow vegetatively well in higher temperature and low humidity climatic conditions.

Although the okra planted were not induced environmentally, yet THI directly affects their growth rates and hence leafy yields and therefore could have resulted into statistical differences ($P \leq 0.05$) among the yield components of okra and average cumulative yield of fresh okra pods, Table 1.

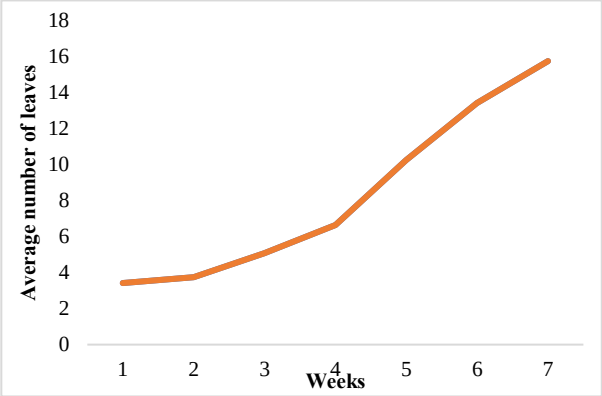

Fig. 1. Average number of leaves of okra at different weeks in 2019 rainy season
Source: Field work 2019.

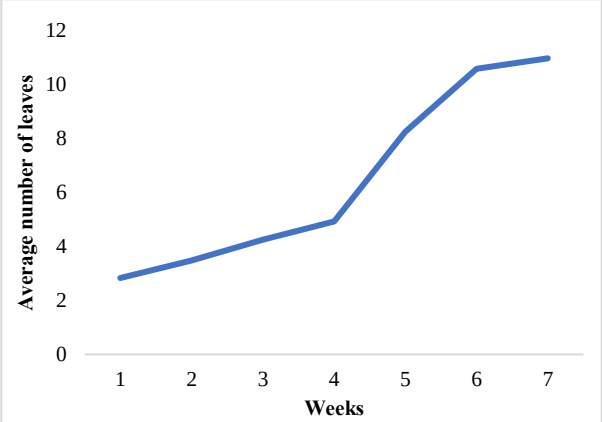

Fig. 2. Average number of leaves of okra at different weeks in 2020 rainy season
Source: Field work 2020.

Table 1. Mean characteristic performances of okra in 2019 and 2020

Years of planting	Plant Height, cm	Leaf Area Index, cm^2	Number of Leaves	Stem Girth, cm	Average Cumulative yield, ton/ha
2019	27.55a ± 7.13	398.50 a± 13.12	16.50 a± 2.11	1.75b ± 6.34	13.285a± 2.34
2020	21.00b ± 2.12	363.69b ± 12.12	15.15 a± 2.00	2.04a± 12.10	12.980b± 2.22
Control	19.00 ± 2.12	313.52 ± 12.12	14.75 ± 2.00	2.00 ± 12.10	11.882 ± 4.12

[ab]= means on the same column with different letters are significantly different. (P≤ 0.05).
Source: Field work 2019-2020.

Table 2. THI mean values at different weeks in 2019 and 2020

Weeks	THI	
	2019	2020
1	34.40a± 2.11	35.28a± 0.62
2	33.52a± 1.10	33.15a± 2.12
3	32.17a± 2.02	32.85a± 1.11
4	29.70ab± 1.12	30.92ab± 1.20
5	31.30ab ± 2.23	31.75ab± 2.10
6	30.90ab± 0.42	31.79ab± 2.01
7	31.12ab± 2.22	31.33ab± 1.10

[ab]= means on the same column with different letters are significantly different. (P≤ 0.05).
Source: Field work 2019-2020.

As a result of the variations in the temperatures and humidities and the THI values, as shown in Table 2 which were moderate and were within the ranges that will allow okra to perform well, okra planted in 2019 gave the highest vegetative stance, Table 1. Also, the Leaf Area Index = 398.50, and number of leaves = 16.50 in 2019, the values in 2019 are respectively 9.57% and 8.91% increase over the 2020 year.

These high vegetative stances could have evidenced in the yields during the days of harvesting which were increasing like sigmoid curves up to the maximum (1,980 kg and 1,800 kg for 2019 and 2020 years respectively), Figure 3.

There were periods of increment from one harvesting to the next for the initial 37 days and thereafter, the diminishing returns set in for the harvesting for the next 40 days after the peak harvest in the 37th day. This was a normal feature of okra farm like other agricultural produce as it shows that an optimum level of output has been attained between the 37 and 41 days when the harvesting have started. The lower R square values depicted in both years could only mean that the dependent variable x (days of harvesting) is favourably explained by independent variable y (yield in tons/ha) in a regression model, that is 70 or 71% of the observed variations in the yield components and cumulative yield of the fresh pods of okra can be explained by the model inputs.

This high vegetativeness recorded could also have resulted into the high cumulative yield of 13.285 and 12.980 tons/ha for 2019 and 2020 years respectively Table 1.

These yields of okra fresh pods got were higher than the highest okra fresh pod yields of 7.36 and 7.43 tons/ha obtained in the earlier experiment by [2] in the south eastern part of the same country and were higher than 4.9 tons/ha okra fresh pod harvested yield recorded by [6] in the Northern part of the country.

These differences could be as a result of soil differences, management and handling (the poultry manure used for the soil could have increased the yield).

The lesser development of vegetative characters in 2020 could have happened because other factor like wind effects could also have affected the yield [12, 13]. This could be so because the precipitations within each of the three months in both years were almost the same and the soil where the crops were experimented upon were almost the same from earlier experiment [14].

Again, due to the low values of the THI in 2019, the crops could be adjudged to be comfortable at those temperatures, humidities and there were no evidence of lodging of okra plant nor torn leaves [17]. Therefore, the okra could be adjudged to have been better in 2019 than in 2020 as evident in the LAI and number of leaves, both parameters signify the increased vegetative yield and fruit yields of the okra.

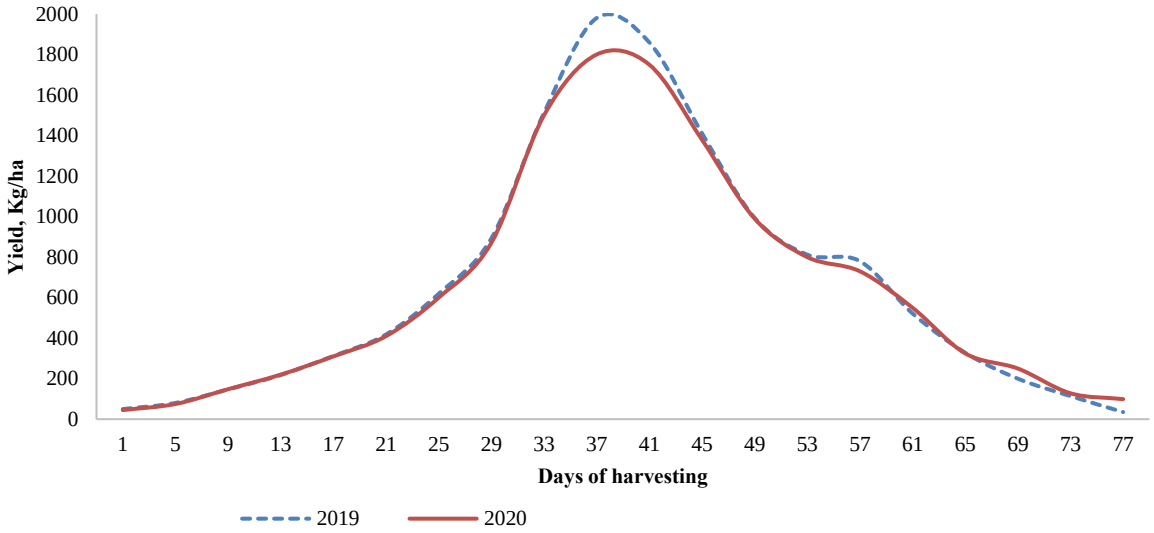

Fig. 3. Average yield of fresh okra pods at 4-days of harvesting interval showing the peak yields at 2019 and 2020 where: the yield in tons/ha is y and the days of harvesting is x, then,
$y= -0.0052x^3 - 0.431x^2 + 63.957x - 316.22$, $R^2 = 70\%$ for year 2019; and,
$y= -0.0045x^3 - 0.4507x^2 + 62.02x – 302$, $R^2 = 71\%$ for year 2020
Source: Fieldwork 2019-2020.

Economic feasibility of the fresh okra pods

The costs were estimated to be ₦862,000 ($1,149.33; Assuming 1$ = ₦750.00) needed for okra farming in the area. This was for both years, as inflation was not set in because of the stability in the supply of premium fuel in the country during the periods (fuel crisis always induce inflation in Nigeria).

The cost of harvesting is always minimal since the market women will always come to the farm to harvest fresh okra pods themselves and weigh themin the farm for monetary cost to be paid to the farmers (Table 3).

Table 3. Table of analysis of cost(₦) incurred, sales made and feasibility

S/N	Items	Cost incurred (₦)	Sales (₦) in 2019	Sales (₦) in 2020	Profit (₦) in 2019	Profit (₦) in 2020
1	Costs of renting a hectare of land for 4 months	15,000				
2	Land clearing	20,000				
3	Procurement of seeds and chemicals and spraying	50,000				
4	Cost of ploughing twice	25,000				
5	Transporting poultry manure and spreading	520,000				
6	Seed planting	32,000				
7	Weeding	110,000				
8	Transportation during Harvesting	32,000				
9	Cost of marketing	18,000				
10	Miscellaneous	40,000				
	Total	862,000 ($1,149.33)				
	Sales in the years	Not Applicable	1,328,500 ($1,771)	1,298,000 ($1,731)		
	Profit for each year				466,500 ($622)	436,000 ($581.33)

Source: Farm works 2020.

The cost price per okra fluctuates, but at the time of the experiment, the cost per 1 kg was ₦100 ($0.13). this translated to ₦1,328,500 ($1,771) in 2019 and ₦1,298,000 ($1,731) in 2020.

Profits after were ₦466,500 ($622) in 2019 and ₦436,000 ($581.33) in 2020, Table 3.

The experiment was feasible because, there were profits of 54.12% and 50.58% of the total cost incurred on the project in 2019 and 2020 respectively.

Besides, there are no any other costs that would be necessary during the cultivation, harvesting and sales by the farmers or the middle women (some of them are women-in-agriculture).

CONCLUSIONS

THI directly affects growth rates of okra and hence their leafy and fresh pods yields. The years of planting and season also resulted into statistical differences among the yield components of okra showing that seasons affect the yield parameters of okra and therefore its vegetativeness and cumulative yield of fresh okra pods. The project is feasible economically in the area.

REFERENCES

[1]Adelakun, O.E., Ade Omowaye, B.I.O., Adeyemi, I.A., Van de Venter, M, 2012, Mineral Composition and the functional attributes of Nigerian okra seed (*Abelmoschus esculentus L*) flour. Food Research International. 47(2):348-352.

[2] Agba, O.A., Mbah, B. N., Asiegbu, J.E., Adinya, I. B., 2011, Effects of spacing on the growth and yield of okra (*Abelmochus esculentus*) L. Moench in Obubra, Cross River State. Global Journal of Agricultural Sciences, 10(1): 57-61, https://www.ajol.info/index.php/gjass/article/view/79078 , Accessed on 02/07/2023

[3]Akintoye, H. A., Adebayo, A. G., Aina, O. O., 2011, Growth and yield response of okra intercropped with live mulches. Asian Journal of Agricultural Research, 5: 146 – 153.

[4]Bemiller, J.N., Whistler, R.L., Barkalow, D.G., Chen, C.C., 1993, Industrial Gums (Third Edition). In: Chapter 9 - Aloe, chia, flaxseed, okra, psyllium seed, quince seed, and tamarindgums, pp. 227-256, https://doi.org/10.1016/B978-0-08-092654-4.50013-9.

[5]Ilupeju, E. A. O., Akanbi, W. B., Olaniyi, J. O., Lawal, B. A., Ojo, M. A., Akintokun, P. O., 2015, Impact of organic and inorganic fertilizers on growth, fruit yield, nutritional and lycopene contents of three varieties of tomato (*Lycopersicon esculentum* (l.) Mill) in Ogbomoso, Nigeria. African Journal of Biotechnology, 14(31):2424-2433.

[6] Jamala, G. Y., Boni, P. G., Abraham, P., Musa, A. M., 2012,Soil status and yield response of different varieties of okra (*Abelmoschus esculentus* (L.) Moench) grown at Mubi floodplain, North Eastern, Nigeria. Journal of Agricultural Biotechnology and Sustainable Development 3(7): 120 -125, September 2012.

[7]Johari, N.S., Asilah, A. M., Zalina, I., Fazhana, I., Ab Latif, Z., Shaibatul' Islamiah, C. M., Tang, J. R., 2020, Effects of Fish Amino Acid (FAA) Application on Growth and Development of Okra (*Abelmoschus Esculentus*) at Different Sampling Times. Journal of Vocational Education Studies. 3(2): 35-42. 10.12928/joves.v3i2.2932.

[8]Katung, M. D., 2017, Productivity of Okra varieties as influenced by seasonal changes in Northern Nigeria. NotulaeBotanicae Horti Agrobotanici Cluj-Napoca, 35(1): 65–71, DOI: https://doi.org/10.15835/nbha351256

[9]Lamidi, W.A., Shittu, K.A., Akinrinade, E.O., 2022, Effect of organic amendments on the vegetative development of okra (*Abelmoschus esculentus L. Moench*) at different wind's directions. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 22(4):359-366.https://managementjournal.usamv.ro/pdf/vol.22_4/Art38.pdf. Accessed on 22/07/2023

[10]Lamidi, W. A., Ola, S. I., 2021, Modelling of the Temperature-Humidity Index (THI) and Ventilation patterns in the rabbits' pens. Ethiopian Journal of Environmental Studies and Management, 14 (4): 487-499. doi:http://doi: https://ejesm.org/doi/v14i4.8

[11]Lamidi W. A., Afolabi M. S., 2016, Influence of Some Environmental Factors on Maize Productivity in Osun State, Nigeria**.** Ethiopian Journal of Environmental Studies and Management, 9 (2), Supplementary 2: 1009-1021.http://www.ajol.info/index.php/ejesm/article/view/150117/139683.Accessed on 02/07/2023

[12]Lamidi, W. A., Afolabi, M. S., Murtadha, M. A., 2020, Performances of cucumber (*Cucumis sativus*) at different heights of the prevailing wind'sspeeds. Journal of Agricultural Engineering and Technology, 25(1):123-134, http://jaet.com.ng/index.php/Jaet/article/view/155/129. Accessed on 18/07/2023

[13]Lamidi, W.A., Akinrinade, E.O., Murtadha, M.A., 2019, Growth and yield of pumpkin (*Telfairiaoccidentalis*L) as affected by different prevailing wind speeds', heights and directions under different organic media. UniosunJournal of Agriculture and Renewable Resources, 3: 25-29, http://www.journals.uniosun.edu.ng/index.php/UJARR/article/view/518/360.Accessed on 02/05/2022

[14]Lamidi, W. A., Nwoke, O.C., Shittu, K.A., 2018, Assessment of soil characteristics under four cropping and land management systems in south west Nigeria.

African Journal of Agricultural Research,13(27): 1400-1406, DOI: 10.5897/AJAR2017.12227

[15]Maduwanthi, A.K.M.R.B., Karunarathna, B., 2019, Growth and Dry Matter Accumulation of Okra (*Abelmoschus esculentus L.*) as Influenced by Different Plating Pattern Under Okra -Cowpea (*Vigna unguiculata* L.) Intercropping. Journal of Horticulture and Plant Research, 7: 81-96. 10.18052/www.scipress.com/JHPR.7.81. Accessed on 03/07/2023.

[16]Murtadha, M.A., Adebooye, O.C., Sanni, T.A., Lamidi, W.A., Afolabi, M.S., 2018, Seasons and Farming Practice Effects on Yield and Growthaattributes of Cucumber (*Cucumis sativus* L.) Varieties. UNIOSUN Journal of Sciences, 3(2): 150-156.

[17]Tiamiyu, R.A., Ahmed, H.G., Muhammad, A.S., 2012, Effect of Sources of Organic Manure on Growth and Yields of Okra (*Abelmoschus esculentus* L.) in Sokoto, Nigeria. Nigerian Journal of Basic and Applied Science, 20(3): 213-216.